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(54) **MOBILE ELECTRONIC SYSTEM AND CHARGING ACCESSORY**

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H02J 7/00 (2006.01)

(52) **U.S. Cl.**
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(58) **Field of Classification Search**
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USPC 320/103, 107, 111, 114, 115
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2006/0087283 A1* 4/2006 Phillips et al. 320/114
2006/0226805 A1* 10/2006 Yu 320/107
2008/0238357 A1* 10/2008 Bourilkov et al. 320/106
2012/0091966 A1* 4/2012 Mori 320/134
2013/0063079 A1* 3/2013 Kawai et al. 320/107

FOREIGN PATENT DOCUMENTS

CN	2041866	7/1989
CN	1163500	10/1997
CN	200962530	10/2007
CN	101421901	4/2009
CN	202616848	12/2012
GB	2386267	9/2003
JP	2000278869	10/2000

OTHER PUBLICATIONS

"Office Action of Taiwan Counterpart Application", issued on Mar. 12, 2015, p. 1-p. 9.
"Office Action of German Counterpart Application", issued on Aug. 20, 2015, p. 1-p. 10.
"Office Action of Chinese Counterpart Application", issued on Sep. 17, 2015, p. 1-p. 8.

* cited by examiner

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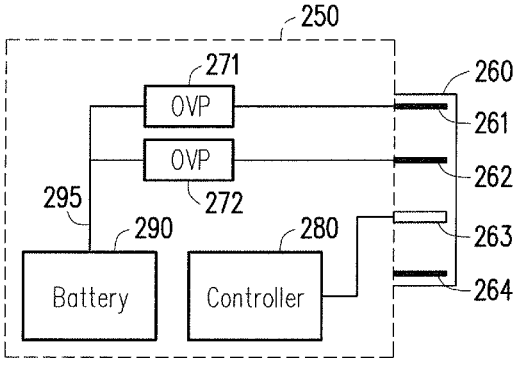
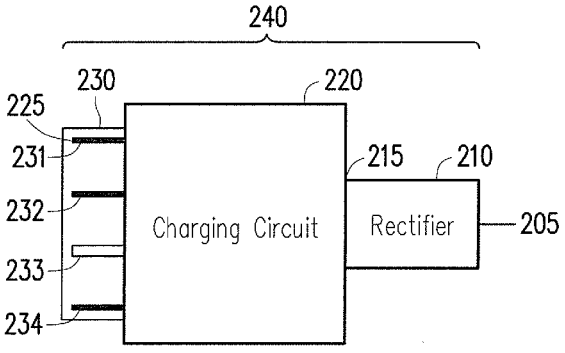
(57) **ABSTRACT**

A mobile electronic system including a mobile electronic device and a charging accessory is provided. The mobile electronic device includes a first connector and a battery. The charging accessory includes a second connector. The first connector and the second connector are configured to couple the mobile electronic device and the charging accessory. When the charging accessory is coupled to an alternating-current voltage and the mobile electronic device, the charging accessory converts the alternating-current voltage into a direct-current voltage, detects an instantaneous voltage of the battery, determines the value of the direct-current voltage according to the instantaneous voltage, and outputs the direct-current voltage to charge the battery.

16 Claims, 3 Drawing Sheets





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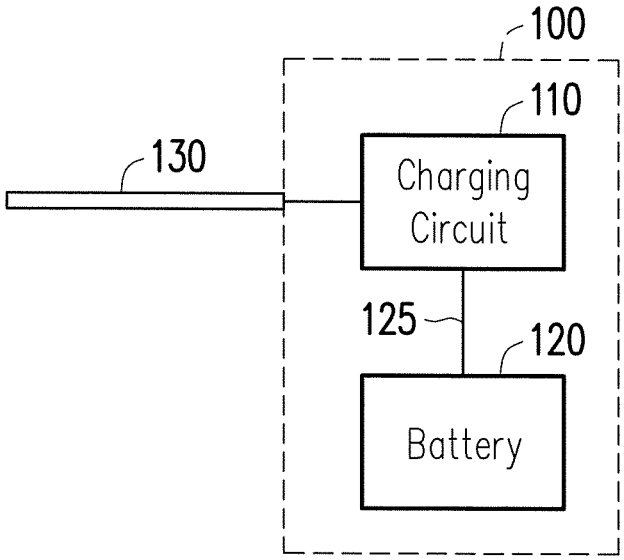

FIG. 1 (RELATED ART)

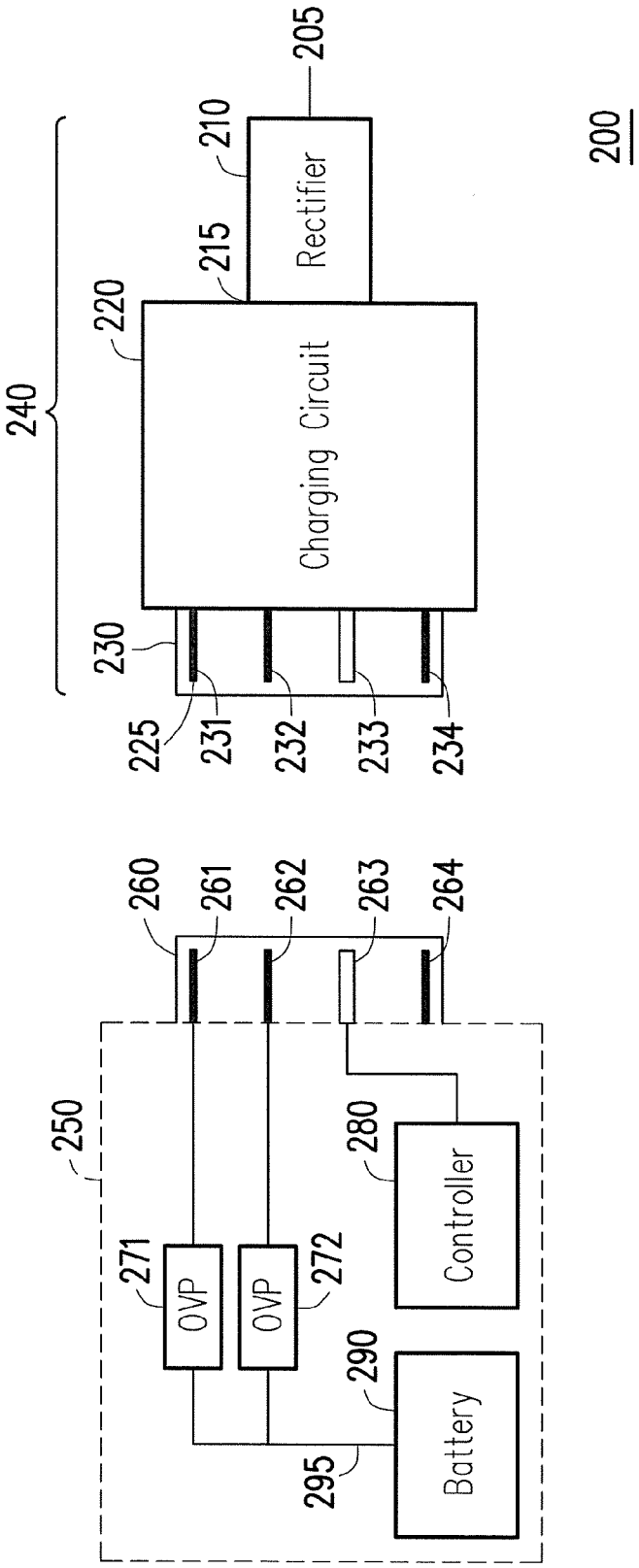
200
205
210
Rectifier
215
220
Charging Circuit
240
230
225
231
232
233
234
260
261
262
263
264
250
280
Controller
271
OVP
272
OVP
290
Battery
295

FIG. 2

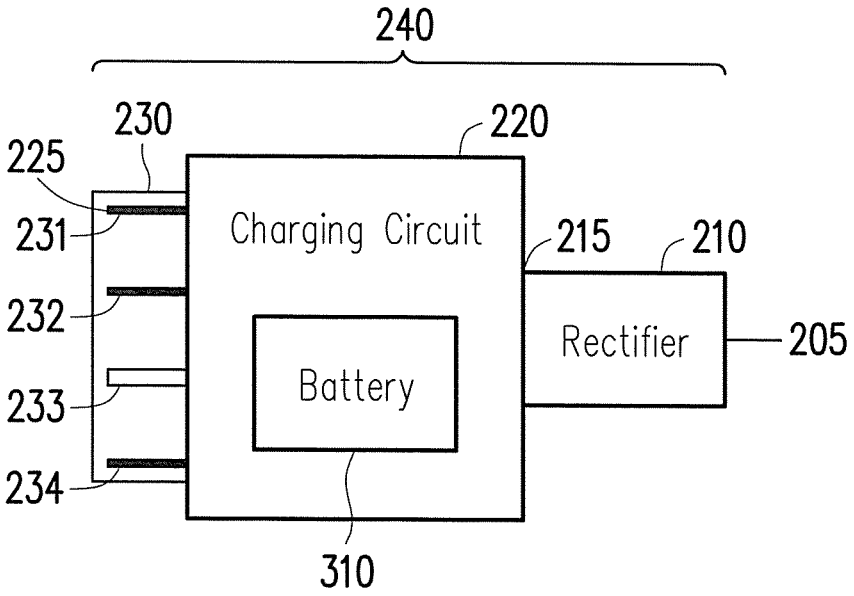
240
230
220
225
231
Charging Circuit
215
210
232
Rectifier
205
233
Battery
234
310

FIG. 3

MOBILE ELECTRONIC SYSTEM AND CHARGING ACCESSORY

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to a mobile electronic system, and more particularly, to a mobile electronic device and a charging accessory.

2. Description of Related Art

A mobile phone needs to be charged frequently. A conventional adapter or the latest universal serial bus (USB) charging mechanism can be adopted for charging a mobile phone.

As shown in FIG. **1**, the mobile phone **100** includes a charging circuit **110** and a battery **120**. The mobile phone **100** receives a charging voltage from a USB cable **130** to charge the battery **120**. The standard charging voltage supplied by a USB is 5 volts. However, the rated voltage of the battery **120** may not be 5 volts. Instead, the rated voltage of the battery **120** may be 3 volts, 3.5 volts, or 4 volts. The charging circuit **110** detects an instantaneous voltage **125** of the battery **120** and converts the charging voltage (5 volts) supplied by the USB cable **130** into a suitable voltage according to the instantaneous voltage **125** to charge the battery **120**.

As to a user, the faster a mobile phone is charged, the better. However, a quick charge requires the charging circuit to supply a large enough charging current. With the limited heat dissipation capability and internal space of any existing mobile phone, the charging current supplied by the charging circuit of the mobile phone is not very large (usually no more than 1 ampere), which therefore is insufficient for satisfying the user's demand for quick charge.

In addition, the problem of insufficient charging voltage also exists in mobile phones. For example, assuming that the voltage supplied by the USB cable **130** comes with an offset and actually 4.95 volts is supplied by the USB cable **130**, and the charging voltage required by the battery **120** is 4.35 volts, in order to quickly charge the battery **120**, the charging circuit **110** has to supply a current of 3 amperes. It can be understood through calculation that the voltage drop from the USB cable **130** to the battery **120** has to be equal to or smaller than 0.6 volts. Namely, the resistance from the USB cable **130** to the battery **120** has to be equal to or smaller than 200 milliohms. However, because the USB cable **130** usually has a resistance of 300 milliohms and the charging circuit **110** usually has a resistance of 100 milliohms, the total resistance (400 milliohms) exceeds the tolerable upper limit. This is one of the problems to be resolved in order to quickly charge a mobile phone.

SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to a mobile electronic system and a charging accessory, in which the problems of insufficient charging current and insufficient charging voltage in a quick charge procedure are resolved.

The present invention provides a mobile electronic system including a mobile electronic device and a charging accessory. The mobile electronic device includes a first connector and a battery. The charging accessory includes a second connector. The first connector and the second connector are configured to couple the mobile electronic device and the charging accessory. When the charging accessory is coupled to an alternating-current voltage and the mobile electronic device, the charging accessory converts the alternating-current voltage into a direct-current voltage, detects an instantaneous voltage of the battery, determines the value of the direct-current voltage according to the instantaneous voltage, and outputs the direct-current voltage to charge the battery.

The present invention provides a charging accessory adapted to a mobile electronic device. The mobile electronic device includes a first connector and a battery. The charging accessory includes a second connector, a rectifier, and a charging circuit. The first connector and the second connector are configured to couple the mobile electronic device and the charging accessory. The charging circuit is coupled between the rectifier and the second connector. When the charging accessory is coupled to an alternating-current voltage and the mobile electronic device, the rectifier converts the alternating-current voltage into a first direct-current voltage. The charging circuit converts the first direct-current voltage into a second direct-current voltage, detects an instantaneous voltage of the battery, determines the value of the second direct-current voltage according to the instantaneous voltage, and outputs the second direct-current voltage to charge the battery.

These and other exemplary embodiments, features, aspects, and advantages of the invention will be described and become more apparent from the detailed description of exemplary embodiments when read in conjunction with accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

FIG. **1** is a diagram of a conventional mobile phone.

FIG. **2** is a diagram of a mobile electronic system according to an embodiment of the present invention.

FIG. **3** is a diagram of a charging accessory according to an embodiment of the present invention.

DESCRIPTION OF THE EMBODIMENTS

Reference will now be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

FIG. **2** is a diagram of a mobile electronic system **200** according to an embodiment of the present invention. The mobile electronic system **200** includes a mobile electronic device **250** and a charging accessory **240**. The mobile electronic device **250** may be a mobile phone, a personal digital assistant (PDA), or a tablet computer. The charging accessory **240** is used for charging the mobile electronic device **250**.

The mobile electronic device **250** includes a connector **260**, over-voltage protection (OVP) circuits **271** and **272**, a controller **280**, and a battery **290**. The controller **280** may be a central processing unit (CPU), a processor, a microprocessor, or an embedded controller (EC) of the mobile electronic device **250**. The connector **260** includes pins **261**, **262**, and **264**, and a communication interface **263**. The pin **261** is coupled to the battery **290** through the OVP circuit **271**, and the pin **262** is coupled to the battery **290** through the OVP circuit **272**. The communication interface **263** is

coupled to the controller **280**. The pin **264** is coupled to a ground of the mobile electronic device **250**.

The charging accessory **240** includes a connector **230**, a charging circuit **220**, and a rectifier **210**. The charging circuit **220** is coupled between the rectifier **210** and the connector **230**. The connector **230** includes pins **231**, **232**, and **234** and a communication interface **233** coupled to the charging circuit **220**. The pin **234** is also coupled to the ground of the charging accessory **240**.

The connector **260** and the connector **230** are configured to couple the mobile electronic device **250** and the charging accessory **240**. When the mobile electronic device **250** and the charging accessory **240** are coupled with each other through the connector **260** and the connector **230**, the pin **261** and the pin **231** are coupled with each other, the pin **262** and the pin **232** are coupled with each other, the communication interface **263** and the communication interface **233** are coupled with each other, the pin **264** and the pin **234** are coupled with each other, and the pin **264** and the pin **234** become a common ground of the mobile electronic device **250** and the charging accessory **240**.

When the charging accessory **240** is coupled to both an alternating-current voltage **205** and the mobile electronic device **250**, the charging accessory **240** charges the mobile electronic device **250**. The alternating-current voltage **205** is usually supplied by a domestic AC power source. Then, the rectifier **210** converts the alternating-current voltage **205** into a direct-current voltage **215**. The charging circuit **220** converts the direct-current voltage **215** into a lower direct-current voltage **225** and outputs the direct-current voltage **225** through the pin **231** and the pin **261** to charge the battery **290**. The charging circuit **220** precisely detects an instantaneous voltage **295** of the battery **290** through the pin **262** and the pin **232** and determines the value of the direct-current voltage **225** according to the instantaneous voltage **295**, so as to supply a most suitable charging voltage to the battery **290**. The direct-current voltage **225** is usually greater than or equal to the instantaneous voltage **295** of the battery **290**. During this charging procedure, the OVP circuits **271** and **272** protect the battery **290** and the mobile electronic device **250**.

When the mobile electronic device **250** is charged, the charging circuit **220** receives a charging specification of the battery **290** from the controller **280** through the communication interface **233** and the communication interface **263**. The charging circuit **220** charges the battery **290** according to the charging specification. The communication interface **233** and the communication interface **263** may include a single circuit and adopt a 1-wire protocol, such as the Dallas protocol. Or, the communication interface **233** and the communication interface **263** may include two circuits and adopt a 2-wire protocol, such as the inter-integrated circuit (I2C) protocol. Additionally, the communication interface **233** and the communication interface **263** may also adopt any other structure and any other communication protocol.

The charging specification of the battery **290** includes the rated voltage of the battery **290** and the maximum charging current acceptable to the battery **290**. The charging circuit **220** controls the charging procedure of the battery **290** to prevent the instantaneous voltage **295** of the battery **290** from exceeding aforementioned rated voltage and the current supplied by the direct-current voltage **225** to the battery **290** from exceeding aforementioned maximum charging current, so that the battery **290** won't be over-charged or even damaged. Once the charging circuit **220** obtains the maximum charging current of the battery **290**, the charging circuit **220** can also supply an optimal charging current to the battery **290**.

FIG. **3** is a diagram of the charging accessory **240** according to another embodiment of the present invention. The major difference between the charging accessory **240** in the present embodiment and the charging accessory **240** in previous embodiment is that in the charging accessory **240** of the present embodiment, the charging circuit **220** includes a battery **310**. The battery **310** stores more electric power than the battery **290**.

When the charging accessory **240** is coupled to the alternating-current voltage **205** but not coupled to the mobile electronic device **250**, the charging circuit **220** charges the battery **310** as a backup with the direct-current voltage **215** supplied by the rectifier **210**. When the charging accessory **240** is coupled to the mobile electronic device **250** but not coupled to the alternating-current voltage **205**, the charging circuit **220** outputs the direct-current voltage **225** by using the electric power stored in the battery **310** through the pin **231** and the pin **261** to charge the battery **290**.

As described above, in the present invention, a charging circuit is disposed outside a mobile electronic device such that the problems of insufficient charging current and insufficient charging voltage during a quick charge procedure of the mobile electronic device can be resolved. This external charging circuit does not have the heat dissipation problem inside the mobile electronic device and is not limited by the internal space of the mobile electronic device. Thus, this charging circuit can supply a large charging current therefore can fulfil the user's demand for quick charge.

In the present invention, the circuit between the external charging circuit and the battery of the mobile electronic device has a simple layout, a small resistance, and accordingly a small voltage drop. Thus, the problem of insufficient charging voltage during the quick charge procedure can be resolved. Moreover, in the present invention, the external charging circuit is not restricted by any existing standard or specification therefore can supply a large charging voltage to tolerate aforementioned voltage drop, which also helps to resolve the problem of insufficient charging voltage during the quick charge procedure.

A battery inside aforementioned external charging circuit can be used as a backup battery in order to bring a more satisfactory experience to the user. A user can carry the charging accessory provided by the present invention around, and when the mobile electronic device is low in battery, use the backup battery in the charging accessory to supply electric power to the mobile electronic device, so that no domestic AC power source or USB power supply of any personal computer is required.

It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the present invention without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the present invention cover modifications and variations of this invention provided they fall within the scope of the following claims and their equivalents.

What is claimed is:

1. A mobile electronic system, comprising:

a mobile electronic device, comprising a first connector and a first battery, wherein the first connector comprises a first pin, a second pin and a fifth pin, wherein the first pin and the second pin are coupled to the first battery, and the fifth pin is coupled to a ground of the mobile electronic device; and

a charging accessory, comprising a second connector, wherein the second connector comprises a third pin, a fourth pin and a sixth pin, wherein the third pin and the fourth pin are coupled to the charging accessory, and the sixth pin is coupled to a ground of the charging accessory,

wherein the first connector and the second connector are configured to couple the mobile electronic device and the charging accessory,

wherein when the mobile electronic device and the charging accessory are coupled with each other through the first connector and the second connector, the first pin is coupled to the third pin, the second pin is coupled to the fourth pin, and the fifth pin and the sixth pin are coupled with each other and become a common ground of the mobile electronic device and the charging accessory,

wherein when the charging accessory is coupled to an alternating-current voltage and the mobile electronic device, the charging accessory converts the alternating-current voltage into a first direct-current voltage, detects an instantaneous voltage of the first battery, determines a value of the first direct-current voltage according to the instantaneous voltage, and outputs the first direct-current voltage to charge the first battery,

wherein the charging accessory outputs the first direct-current voltage through the first pin, the third pin, the fifth pin and the sixth pin to charge the first battery, and the charging accessory detects the instantaneous voltage through the second pin, the fourth pin, the fifth pin and the sixth pin.

2. The mobile electronic system according to claim **1**, wherein the first direct-current voltage is greater than or equal to the instantaneous voltage.

3. The mobile electronic system according to claim **1**, wherein the charging accessory further comprises:

a rectifier, converting the alternating-current voltage into a second direct-current voltage; and

a charging circuit, coupled between the rectifier and the second connector, converting the second direct-current voltage into the first direct-current voltage, detecting the instantaneous voltage, determining the value of the first direct-current voltage according to the instantaneous voltage, and outputting the first direct-current voltage to charge the first battery.

4. The mobile electronic system according to claim **3**, wherein the charging circuit outputs the first direct-current voltage through the first pin and the third pin to charge the first battery, and the charging circuit detects the instantaneous voltage through the second pin and the fourth pin.

5. The mobile electronic system according to claim **4**, wherein the mobile electronic device further comprises:

a first over-voltage protection (OVP) circuit, coupled between the first pin and the first battery; and

a second OVP circuit, coupled between the second pin and the first battery.

6. The mobile electronic system according to claim **3**, wherein the mobile electronic device further comprises a controller, and the controller is coupled to the first connector; when the mobile electronic device and the charging accessory are coupled with each other through the first connector and the second connector, the charging circuit receives a charging specification of the first battery from the controller through the first connector and the second connector, and the charging circuit charges the first battery according to the charging specification.

7. The mobile electronic system according to claim **6**, wherein the first connector further comprises a first communication interface, and the first communication interface is coupled to the controller; the second connector further comprises a second communication interface, and the second communication interface is coupled to the charging circuit; when the mobile electronic device and the charging accessory are coupled with each other through the first connector and the second connector, the first communication interface and the second communication interface are coupled with each other, and the charging circuit receives the charging specification from the controller through the first communication interface and the second communication interface.

8. The mobile electronic system according to claim **6**, wherein the charging specification comprises a rated voltage of the first battery, and the charging circuit controls a charging procedure of the first battery to prevent the instantaneous voltage from exceeding the rated voltage.

9. The mobile electronic system according to claim **6**, wherein the charging specification comprises a maximum charging current of the first battery, and the charging circuit controls a charging procedure of the first battery to prevent a current supplied by the first direct-current voltage to the first battery from exceeding the maximum charging current.

10. The mobile electronic system according to claim **3**, wherein the charging circuit comprises a second battery; when the charging accessory is coupled to the alternating-current voltage and not coupled to the mobile electronic device, the charging circuit charges the second battery with the second direct-current voltage; when the charging accessory is coupled to the mobile electronic device and not coupled to the alternating-current voltage, the charging circuit outputs the first direct-current voltage from the second battery to charge the first battery.

11. A charging accessory, adapted to a mobile electronic device, wherein the mobile electronic device comprises a first connector and a first battery, wherein the first connector comprises a first pin, a second pin and a fifth pin, wherein the first pin and the second pin are coupled to the first battery, the charging accessory comprising:

a second connector, wherein the first connector and the second connector are configured to couple the mobile electronic device and the charging accessory, and the second connector comprises a third pin, a fourth pin and a sixth pin;

a rectifier; and

a charging circuit, coupled between the rectifier and the second connector, wherein the third pin and the fourth pin are coupled to the charging circuit, and the sixth pin is coupled to a ground of the charging circuit,

wherein when the charging accessory is coupled to an alternating-current voltage and the mobile electronic device, the rectifier converts the alternating-current voltage into a first direct-current voltage;

wherein the charging circuit converts the first direct-current voltage into a second direct-current voltage, detects an instantaneous voltage of the first battery, determines a value of the second direct-current voltage according to the instantaneous voltage, and outputs the second direct-current voltage to charge the first battery,

wherein when the mobile electronic device and the charging accessory are coupled with each other through the first connector and the second connector, the fifth pin and the sixth pin are coupled with each other and become a common ground of the mobile electronic device and the charging circuit, the charging circuit

outputs the second direct-current voltage through the first pin, the third pin, the fifth pin and the sixth pin to charge the first battery, and the charging circuit detects the instantaneous voltage through the second pin, and the fourth pin, the fifth pin and the sixth pin.

12. The charging accessory according to claim **11**, wherein the second direct-current voltage is greater than or equal to the instantaneous voltage.

13. The charging accessory according to claim **11**, wherein when the mobile electronic device and the charging accessory are coupled with each other through the first connector and the second connector, the charging circuit receives a charging specification of the first battery from the mobile electronic device through the first connector and the second connector, and the charging circuit charges the first battery according to the charging specification.

14. The charging accessory according to claim **13**, wherein the charging specification comprises a rated voltage of the first battery, and the charging circuit controls a charging procedure of the first battery to prevent the instantaneous voltage from exceeding the rated voltage.

15. The charging accessory according to claim **13**, wherein the charging specification comprises a maximum charging current of the first battery, and the charging circuit controls a charging procedure of the first battery to prevent a current supplied by the second direct-current voltage to the first battery from exceeding the maximum charging current.

16. The charging accessory according to claim **11**, wherein the charging circuit comprises a second battery; when the charging accessory is coupled to the alternating-current voltage and not coupled to the mobile electronic device, the charging circuit charges the second battery with the first direct-current voltage; when the charging accessory is coupled to the mobile electronic device and not coupled to the alternating-current voltage, the charging circuit outputs the second direct-current voltage from the second battery to charge the first battery.

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